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RESONANT ARRANGEMENT FOR A LINEAR COMPRESSOR

Field of the Invention

The present invention refers, in general, to a constructive arrangement for a resonant compressor of the type driven by a linear motor to be applied in refrigeration systems and which presents a piston reciprocating inside a cylinder.

Background of the Invention

In a reciprocating compressor driven by a linear motor, the gas suction and gas compression operations are performed by the reciprocating axial movements of the piston inside a cylinder, which is closed by a cylinder head and mounted within a hermetic shell, in the cylinder head being positioned the suction and discharge valves that control the admission and discharge of the gas in relation to the cylinder. The piston is driven by an actuating means that supports magnetic components driven by a linear motor affixed to the shell of the compressor.

In some constructions, the piston is mounted against a resonant spring means in the form of an assembly of flat springs, affixed to the hermetic shell of the compressor to operate as guides to the axial displacement of the piston and make the whole assembly act resonantly in a predetermined frequency, allowing the linear motor to be adequately dimensioned to continuously supply energy to the compressor upon operation.

The piston is mounted against the spring assembly through a flexible rod, said spring assembly is rigidly mounted against the cylinder, and the piston, the actuator, the magnetic component, the flexible rod, and the assembly of flat springs form together the resonant assembly of the compressor.

In this construction, the piston is mounted against an

assembly of flat springs made of a spring steel plate, through a flexible rod that has the function to neutralize the forces resulting from errors occurred during production and assembly of the parts, in order not to transmit said forces in their totality to the piston, avoiding the wear of said piston in relation to the cylinder.

This construction presents some disadvantages, such as the need to have a flexible rod to neutralize the forces resulting from the errors occurred during production and assembly of the parts. This flexible rod is also a relatively difficult component to be obtained, since it must be produced with special materials. Furthermore, such flat springs are very expensive, as they require very sophisticated cutting and finishing processes.

In another known construction, the assembly of flat springs is replaced by a system of helical springs, in which a first helical spring is mounted between the actuating means and the cylinder, and a second helical spring is mounted between the actuating means and the shell of the compressor and, in this construction, the resonant assembly of the compressor is formed by the piston, the actuating means, the magnet, and the helical springs.

This construction also presents disadvantages, such as requiring a compressor with larger dimensions, as a function of the need to use a pair of helical springs, which cannot be properly affixed to be submitted to traction forces.

Moreover, the helical springs have the characteristic of generating eccentric and shearing forces on the surfaces on which they are seated, provoking forces on the bearings of the piston of the compressor, generating noise and wear and reducing the life of the

compressor.

Objects of the Invention

Thus, it is an object of the present invention to provide a resonant system for a linear compressor, presenting an easy and reliable assembly and fixation, which allows said resonant system to be submitted to traction and compressive forces during operation of the compressor, without losing the positioning in relation to the parts to which it is affixed, and which does not present radial and lateral force components during the movement of the piston that may result in radial forces to the piston.

A further object of the present invention is to provide a resonant system of low cost and which dispenses the use of the flexible rod and of the flat or helical springs.

Summary of the Invention

These and other objectives are achieved through a resonant arrangement for a linear compressor, comprising a non-resonant assembly formed by a motor and a cylinder; a resonant assembly formed by a piston reciprocating inside the cylinder; an actuating means operatively coupling the piston to the motor, and at least one spring means presenting an elongated tubular body, coaxial to the axis of the piston, and which is operatively coupled to the actuating means and to the non-resonant assembly, said tubular body having at least part of the extension thereof folded in circumferential sectors, each circumferential sector being elastically deformed in the axial direction upon the displacement of the piston.

Brief Description of the Drawings

The invention will be described below, with reference to the enclosed drawings, in which:

Figure 1 is a schematic longitudinal diametrical

sectional view of a hermetic compressor of the type driven by a linear motor and presenting a resonant means, constructed according to the prior art;

Figure 2 is a schematic longitudinal diametrical sectional view of a hermetic compressor of the type driven by a linear motor and presenting another construction for the resonant means of the prior art;

Figure 3 is a schematic longitudinal diametrical sectional view of a hermetic compressor of the type driven by a linear motor and presenting a resonant means constructed according to the present invention;

Figure 4 illustrate, schematically, the compressor shown in figure 3, in a constructive variation of the present invention;

Figure 5 is a schematic lateral view of the resonant means of the present invention; and

Figure 6 is a schematic perspective view of the resonant means of the present invention illustrated in figure 5.

Description of the Illustrated Embodiments

The present invention will be described in relation to a reciprocating compressor driven by a linear motor of the type used in refrigeration systems and comprising a motor-compressor assembly, including a non-resonant assembly formed by a linear motor and a cylinder 1, and a resonant assembly formed by a piston 2 reciprocating inside the cylinder 1, and an actuating means 3, external to the cylinder 1 and carrying a magnet 4 that is axially impelled upon energization of the linear motor, said actuating means 3 operatively coupling the piston 2 to the linear motor.

According to the prior art construction illustrated in figures 1 and 2, the components mentioned above are mounted inside a hermetic shell 10.

As illustrated in the enclosed figures, the linear

motor is mounted around the cylinder 1 and the piston 2 and comprises a stack of internal laminations 5 with a coil 6 inserted therein, and a stack of external laminations 7.

In the construction illustrated in figures 1 and 2, the compressor also includes conventional resonant spring means, mounted in constant compression to the resonant assembly and to the non-resonant assembly, and which are elastically axially deformable in the displacement direction of the piston 2.

In the construction of figure 1, the compressor comprises a spring means, in the form of an assembly of flat springs 10 made of a spring steel plate and to which is mounted the piston 2 through a flexible rod 8.

In the embodiment of figure 2, the compressor comprises a pair of spring means, for example a pair of helical springs 20, a first helical spring 20 mounted between the actuating means 3 and the cylinder 1, and a second helical spring 20 mounted between said actuating means 3 and the shell 10 of the compressor.

According to the illustrations, the cylinder 1 has an end closed by a valve plate 30, provided with a suction valve 31 and a discharge valve 32, which allows the selective fluid communication between a compression chamber 9 defined between a top portion of the piston 2 and the valve plate 30 and respective internal portions of a cylinder head 40 that are respectively maintained in fluid communication with the low and high pressure sides of the refrigeration system to which the compressor is coupled.

These constructions present the disadvantages discussed above.

According to the present invention, the prior art disadvantages are avoided with a resonant arrangement

for a linear compressor that comprises at least one spring means presenting an elongated tubular body 50, which is coaxial to the axis of the piston 2 and has an end 51 operatively coupled to the actuating means 3, and an opposite end 52 operatively coupled to the non-resonant assembly, said tubular body 50 having at least part of its extension folded in circumferential sectors 53 that are symmetric in relation to the axis of said tubular body 50, and for example, orthogonal to the axis of the piston 2, each circumferential sector 53 being elastically deformed in the axial direction upon the displacement of piston 2.

According to a way of carrying out the present invention, the circumferential sectors 53 present the same cross section profile, for example a substantially "V" shaped profile, such as illustrated in figure 5, or a substantially "U" shaped profile.

In the construction illustrated in which the circumferential sector 53 has a "V" shaped profile, the elastic deformation of each said circumferential sector 53 upon displacement of the piston occurs by variation of its respective dihedral angle.

Although in the illustrated constructive alternative the circumferential sectors 53 present the same dihedral angle, it should be understood that the solutions in which the circumferential sectors 53 present different cross section profiles along the longitudinal extension of the tubular body 50 and different dihedral angles to said circumferential sectors 53 are also possible.

According to a way of carrying out the present invention, the tubular body is hollow, allowing for the fluid communication between the compression chamber 9 and the interior of the shell 10, which in this case is of the conventional hermetic type.

In the embodiment of the invention, as illustrated, the tubular body 50 presents a non-hollow lateral surface 54. In this case, since an end 51 of the tubular body 50 is hermetically affixed to the cylinder 1, and the opposite end 52 is hermetically affixed to the actuating means 3, said tubular body 50 blocks the fluid communication between the compression chamber 9 and the exterior of cylinder 1 through gaps existing between the piston 2 and the cylinder 1. In this construction, the shell of the compressor, if provided, does not need to be hermetic, since the sealing between the compression chamber 9 and the interior of said shell is obtained by the tubular body 50.

According to the illustration in figure 3, the compressor further presents another spring means in the form of a tubular body 50, having an end 51 affixed to the actuating means 3, and the other end 52 affixed to the shell 10. The fixation of each of the ends 51, 52 of each tubular body 50 to the respective parts defined by the cylinder 1, the actuating means 3, and the shell 10 is achieved for example, by one of the processes of welding, gluing or screwing.

In a form of executing the invention, each of the ends 51, 52 of each tubular body 50 is defined by a respective tubular extension not presenting the circumferential sectors 53 and which is dimensioned to provide a fitting to the respective part to which it is affixed. However, other constructive forms for said ends 51, 52 are possible, such as radial projections to be orthogonally affixed to the axis of the piston 2.

In the illustrated construction, each part to which is affixed an adjacent end 51, 52 of the tubular body 50 is provided with at least one circumferential tooth

that is coaxial to the axis of the piston 2 in order to fit said respective end 51, 52.

According to the illustrations in figure 3, a lower end portion of the cylinder 1 is provided with an annular cutting 1a, which defines the tooth for the fixation of an adjacent end 51 of the tubular body 50, and the actuating means 3 is provided with a first annular tooth 3a facing the cylinder 1 and securing the other end 52 of the tubular body 50.

In the construction presenting two spring means, such as illustrated in figure 4, the actuating means 3 is further provided with a second annular tooth 3b, facing a lower portion of the shell 10 in order to affix an end 51 of other tubular body 50. In this construction, the shell 10 presents a respective annular salience, which is coaxial and aligned in relation to the second tooth 3b of the actuating means 3 that secures the other end 52 of the tubular body 50. In the illustrated constructions, the circumferential teeth are continuous, coaxial and axially aligned to each other.